Mechelectiv

VOL. 17 OCTOBER, 1957 NO. 1

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- HEAT PUMPS

SCHOOL OF ENGINEERING
THE GEORGE WASHINGTON UNIVERSITY

OCTOBER 1957

Only STEEL can do so many jobs so well

Steelaire Home. The entire structural frame of this house is made from tough, cold-formed steel, so it is unaffected by rot, fungus, and termites. Even more important is the fact that the steel frame resists warping and sagging. It's one of a line of *Steelaire* homes and is made by the U. S. Steel Homes Division of United States Steel.

World's Biggest Crowd. On power shovels, a "crowd" is the arm which moves the dipper and dipper-stick forward and back. It coordinates closely with the lift motion of the dipper, and is a key part in the operation of the shovel which must withstand extremes of stress at any temperature. This is a picture of the biggest crowd ever built, now installed on the biggest power shovel in the world. It's made from USS "T-1" Steel, the remarkable new constructional alloy steel developed by United States Steel. An exceptionally strong and tough steel, it is noted for its welding characteristics. *"USS" and "T-1" are registered trademarks.*

Slap That Bermudavarius! The Talbot Brothers of Bermuda, famous for their colorful calypso music, recently retired their homemade packing-case "bass viol," and proudly premiered in its place the world's first Stainless Steel bass viol (or dog house or Bermudavarius, as it's customarily referred to). An exact replica in USS Stainless Steel of their original homemade design, it was built for them under U. S. Steel's supervision by a well-known manufacturer of Stainless Steel sinks who commented that the fabricating job wasn't difficult—but certainly was *different.*

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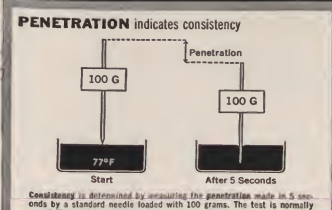
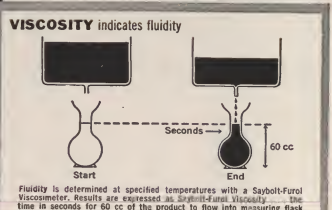


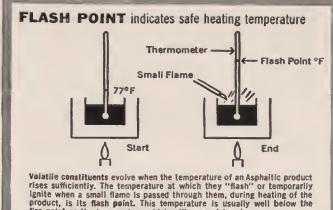
Consistency is determined by measuring the penetration made in 5 seconds by a standard needle loaded with 100 grams. The test is normally run at 77°F and penetration is measured in units of 0.1 mm.

FIG. 1



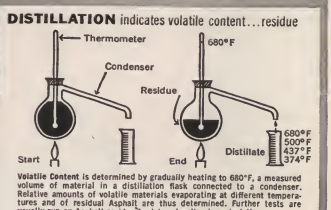
Fluidity is determined at specified temperatures with a Saybolt-Furol Viscosimeter. Results are expressed as Saybolt-Furol Viscosity — the time in seconds for 60 cc of the product to flow into measuring flask through a precisely dimensioned orifice. The slower the flow, the higher the viscosity.

FIG. 2



Volatile constituents evolve when the temperature of an Asphaltic product rises sufficiently. The temperature at which they "flash" or temporarily ignite when a small flame is passed through them, during heating of the product, is its flash point. This temperature is usually well below the fire point or the temperature which will support burning.

FIG. 3



Volatile Content is determined by gradually heating to 680°F, a measured volume of material in a distillation flask connected to a condenser. Relative amounts of volatile materials evaporating at different temperatures and of residual Asphalt are thus determined. Further tests are usually run on Asphalt residue to determine its characteristics.

FIG. 4

Tests on Asphaltic Materials

The suitability of an Asphaltic material for highway or other use depends upon characteristics which can be determined by a series of tests. Four of the principal tests are:

PENETRATION TEST (Fig. 1)

indicates the *consistency* or hardness of Asphalt cements (which are semi-solids) used in hot-mix Asphalt pavements. The softer the product, the greater its number of penetration units. On the basis of consistency . . . denoted by penetration ranges . . . Asphalt cements are classified into grades. Those paving grades now recommended by The Asphalt Institute are:

PENETRATION GRADES

60-70 85-100 120-150 200-300

(a 40-50 penetration grade is recommended for special and industrial uses.)

VISCOSITY TEST (Fig. 2)

indicates the fluidity of liquid Asphalts. Viscosity measures the consistency of these products just as the penetration test measures the consistency of semi-solid products. Those liquids flowing too slowly for accurate measurements by the viscosimeter at 77°F are tested at higher temperatures—usually at 122°F, 140°F, or 180°F.

FLASH POINT (Fig. 3)

indicates the temperature at which vapor ignition may occur when heating and manipulating Asphaltic materials.

DISTILLATION TEST (Fig. 4)

indicates the amount of Asphaltic residue to expect in liquid Asphalts after lighter constituents volatilize under manipulation and use. It indicates, too, the relative rapidity at which these lighter constituents "cure" out of the Asphalt.

Be sure to cut out and file this data sheet, as well as future sheets and those previously inserted in this publication. Make them your professional reference material.

THE ASPHALT INSTITUTE, Asphalt Institute Building, College Park, Maryland

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The Mechelectiv

VOL. 17 OCTOBER, 1957 NO. 1

SCHOOL OF ENGINEERING, THE GEORGE WASHINGTON UNIVERSITY

In This Issue:

ARTICLES

DEPARTMENTS

ON OUR COVER

The T-2 tanker, *S. S. Schenectady,* which snapped in two on January 16, 1943, while being moored to her dock.

Published at the George Washington University by direction of the Engineers' Council. Published six times during the school year in October, November, December, March, April, and May. Entered as second class matter March 6, 1951, at the Post Office at Washington, D. C., under the act of March 3, 1879. Address communications to Mechelectiv Magazine, Davis-Hodgkins House, George Washington University, Washington 6, D. C. or telephone STerling 3-0250, Extension 528.

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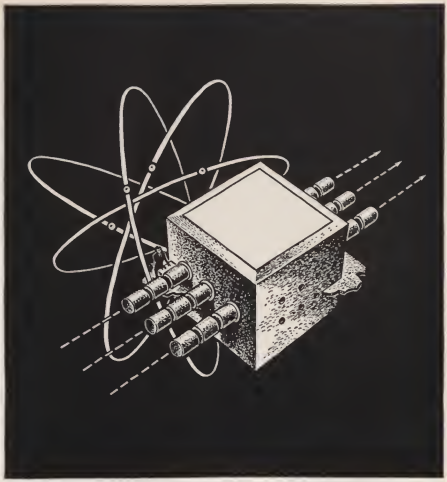

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FAMILIAR FACES

IRV SCHICK will graduate next June with a degree in Electrical Engineering with high distinction. If he holds true to form, he will graduate with a Q.P.I. of over 3.97 which is probably the second highest in the history of the School of Engineering. When Irv left his hometown of Hazleton, Pa. to enter the Air Force during World War II he probably hadn't the faintest idea that he would be graduating from GWU. He ended his three years of service as a sergeant in the S. W. Pacific Area. His military duties had consisted primarily of maintenance of ground communications equipment.

After leaving the service, Irv enroled in Bliss Electrical School and, after graduation, stayed on as an instructor. In 1950 the school was sold to Montgomery County and became Montgomery Junior College. Irv continued to teach and went to GW nights to work toward his E.E. degree. He is now the Head of the Department of Electrical Technology at Montgomery Junior College.

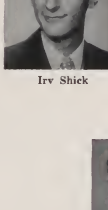
Irv has also compiled a remarkable record in extracurricular activities at GW. He is Past President of Sigma Pi Sigma, Engineers' Council Representative from Sigma Tau, and member of Theta Tau and AIEE-IRE.

Irv isn't sure just where he will apply his talents after graduation, other than the fact that he will operate in the field of Electrical Engineering like his brother who works as an electrical engineer for IBM.

NORM STREET has a first-hand knowledge of the geography of the U. S. because he has lived in most sections of the country at one time or another. He was born in Utah, lived in several out of the way spots in the western part of the country, went to high school in Winnetka, Illinois, and enrolled as an E.E. at Northwestern before joining the Navy in 1951. He spent most of his Navy time as an instructor at Sonar School at Key West, Florida. After geting out of the Navy, he came to the Washington area and went to work for Melpar. He started GW night school in 1954 and started full-time in the fall of 1955.

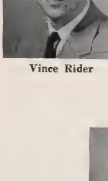
Norm's hobby consists of "following a broad streak of curiosity which leads in all directions simultaneously." This leads to a love of conversation, best primed with a schooner or two at Brownley's after a student activity meeting. For a student who is more interested in the academic side of student life than the activities, Norm has compiled an enviable activity record. He has been D-H House Manager, member of the Engineers' Council and the *Mecheleciv* staff, and at present is Vice-President of Sigma Tau and Chairman of the AIEE-IRE Student Branch.

Norm would like to work for a while before considering graduate work but says that the first course he intends to take after getting his diploma will be in ballroom dancing.



Irv Shick

Norm Street



Vince Rider

Ray Sullivan

VINCE RIDER expresses his views on extracurricular activities in his article which starts on page 10 of this issue. His record proves that he practices what he preaches. This record includes Circulation Manager, Business Manager and Office Manager of *Mechelecivy;* Treasurer of Pi Delta Epsilon, Journalism Honorary; Vice Regent of Theta Tau; and the top job in the School of Engineering, President of the Engineers' Council.

Vince was born in Marilla, New York, and left there to go into the Army. Most of his time was spent at the Engineer Center at Fort Belvoir, where he taught interior wiring; however, he found plenty of time to engage in his favorite pastime, athletics. While on a jaunt to the beach with his buddies, he met the girl who became his wife in January 1954.

Vince was discharged from the Army on June 15, 1954, and started GW on June 21. His work as an electrician led him into the power option of the E.E. curriculum. He is furthering his interest by serving as a student assistant in the Power Lab.

Vince plans to go back to upstate New York after graduation but further than that his plans are indefinite. Right now the thing uppermost in his mind is to try to build student interest and spirit in the activities of the School of Engineering.

RAY SULLIVAN was elected Freshman Representative to the Engineers' Council when the office was first established in 1954. Since then he has taken part in several activities but his prime interest is in *Mechelecivy*, having served as writer, Associate Editor, and is serving his second term as Editor. He also edited both Volumes I and II of the *Engineers' Guide*, Student Handbook of the School of Engineering, and is Engineering Editor for the *Cherry Tree*. Needless to say, with all this publications service, Ray is also a member of the Journalism Honorary, Pi Delta Epsilon, and has served that organization as Secretary and Vice President. In addition he has been active in Theta Tau, of which he is Regent. He was recognized for his activities record by being made a charter member of the Order of Scarlet, Sophomore-Junior Men's Honorary.

Ray left his hometown, International Falls, Minnesota, to enter the Navy, which he left in 1950 as an Aviation Electronics Technician First Class. He was employed by Philco Corp. as a technical writer and was sent to Washington on a contract assignment. When the contract expired, he decided to hang out his shingle as a free lance technical writer and prides himself on having been able to make ends meet in this feast or famine profession ever since.

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FACULTY PAGE

The Need for More Mathematics for Engineering Students

By LLEWELLYN A. RUBIN

Instructor in Electrical Engineering

Mr. Rubin, a native of Doylestown, Pa., was graduated from the University of Pennsylvania in June, 1955, with the degree of Bachelor of Science in Electrical Engineering (with distinction). Up until that time he had been active in his own business, the States Tourist Cottages, Doylestown, Pa., where he was the resident manager. Before and during his college days at Penn, Mr. Rubin was employed by the Naval Air Development Center, Johnsville, Pa., as an Engineering Aide in the Analytical and Computer Laboratory, the home of the "Typhoon Analog Computer." On graduation from Penn, Mr. Rubin stayed on as an Assistant Instructor doing research in Operations Research in Weapons Systems. Later he went into teaching in the Moore School of Electrical Engineering. Mr. Rubin came to The George Washington University in August of 1956 and has been a full-time instructor in the Department of Electrical Engineering ever since. He is currently working on his thesis for his Master's degree which he expects to receive from the University of Pennsylvania next January.

I suppose that in this first issue of *Mecheleciv* for the 1957-58 academic year, it would be proper to say flowery things such as, "welcome back," "good luck for the coming year," etc. I do say these things sincerely but as usual I would like to say a bit more.

For some years I have felt that many graduate engineers are not competent in the understanding and use of mathematics. Others share this view. Many say that they wish they were better at mathematics. There are those who cannot cope with graduate work because of "holes" in their mathematics background. There are many undergraduates in engineering in exactly the same category.

Recently and up until a year ago, only Civil Engineers took an additional mathematics course (Math 112). This year Math 112 is required of all Electrical Engineers. This makes a total of 15 credit hours of mathematics. There are schools where formal mathematics entails 18 to 20 hours of the engineering curricula. In these schools it is probable that something else is shortened to provide the extra mathematics hours.

Practically every first-class engineering school exerts continuous effort to strengthen its curricula. The purpose of this is not, as many of you imagine, to make things more difficult for you. The actual aim of such curricula modifications is to make the graduates of their schools better engineers and citizens. It is a bit difficult to explain why the increased study of mathematics will make you a better engineer and citizen. The answer to, "why a better engineer," lies in the fact that to a greater and greater extent, the existing problems to be solved by engineers find easiest and best solution in mathematics. The day of empricism is nearly at an end. All the good, meaty problems requiring mixing a new batch of concrete have been poured, and to a great extent the remaining problems in concrete will be solved by use of solid-state physics, a subject strongly dependent upon a clear understanding of advanced mathematics. The other problem, that of better citizens, is justified on the grounds that mathematics when studied hard and well affords the opportunity of gaining valuable experience in solving problems in an orderly, logical and analytical way. This experience is valuable not only in your engineering work but also in executing your responsibilities of citizenship towards your community. It is well recognized that scientists make worthwhile contributions to the welfare of their communities through their ability to evaluate and solve difficult problems using the objective and analytical approach so well learned in the study of mathematics.

You may ask, if there is such a need for more mathematics, why does not the faculty insert more mathematics courses in the curricula. The situation is not that simple, for in an already

(Please turn to page 34.)

COUNCIL COUNSEL

By VINCENT W. RIDER, B.E.E., '58
President, Engineers' Council

I would like to take this opportunity to welcome the new and returning students and wish you all the best of luck in the coming year.

In order that I might do an effective job as President of the Engineers' Council, I consider it necessary that I know as many of you as possible. Toward this end I believe we would have a good start if you would bring your lunch to the Davis-Hodgkins House at 731 22d St. or stop by before your evening class. There you will find a soft drink machine, soft chairs, television, and a friendly atmosphere. This is the engineer's lounge and a good place to exchange ideas on the events of the day. This would also give you an opportunity to get to know your fellow students. Here also are study rooms with blackboards where you can work individually or in groups.

The shortage of engineers, professional ethics of engineers, and the high salaries of engineers are frequently the topics of discussion for a piece of writing such as this in the first issue of *Mecheleciv*. I would like to extend the list and bring it a little closer to you as students in engineering. It is possible for a person to enter the School of Engineering, study four or more years and receive a diploma without getting acquainted with his classmates, professors, or school. I am sure this could happen at other universities and colleges, but it is more evident here with our urban campus and the many part-time students.

For the man already in a responsible position and looking for a promotion for which a degree is necessary, this hermit-type existence might suffice; but for the younger man who has yet to make his place in the world, the degree alone cannot be relied upon to carry him up the ladder of success. In order to get the required engineering fundamentals in the four years allotted, it is necessary to neglect the liberal arts courses needed to round out our education. However, this does not mean that while in school you cannot attain the qualities and the experience necessary for you to take your place in industry. What it does mean is that besides your studies you must put forth additional effort and become active in one or more activities of your choice. The words "your choice" in the last sentence are very important. To join an organization just for the sake of joining will not build up such qualities as sociability, tact, initiative, and leadership. You must take an active part to be of any value to yourself or the organization of which you are a part.

Here at the George Washington University there is a wide variety of activities of which the engineer may avail himself. First, we have the Engineers' Council whose purpose is to provide liaison between the student body of the School of Engineering and the faculty, administration, and student government of the University in all matters affecting the general interest and welfare of the student body of the School of Engineering or the University.

The Council is made up of two members of each class in the undergraduate school, two graduate students, the business manager of *Mecheleciv*, the Davis-Hodgkins House manager, the Student Council representative, a Theta Tau representative, a Sigma Tau representative, and a representative from each of the four professional societies.

Annually, the Council sponsors such activities as the Engineers' Mixer (a social gathering of students, faculty, and alumni to welcome new students), Christmas Tree Lighting Ceremony (a traditional program in which the students of the School of Engineering provide the University with a lighted Christmas Tree), registration program (help given freshmen and new students in registration problems), and the annual Engineers' Banquet and Ball which climaxes the year's work with a dinner, dance, and awards.

The four member professional societies of the Council are the American Societies of Civil and Mechanical Engineers, the American Institute of Electrical Engineers, and the Institute of Radio Engineers. The meetings of these societies provide the student member an excellent opportunity to socialize with fellow students and professors while being entertained by professional speakers, movies, field trips, and various other programs related to his chosen vocation.

(Please turn to page 34.)

HAS THE HEAT PUMP ARRIVED?

By ROBERT M. KEITH, B.E.E., '58

Since William Thomson first published his theory of reversibility about one hundred years ago, much has been written about the theory of operation of the heat pump. Comparatively little has been published about the applications of heat pumps. The majority of the articles on heat pump applications have appeared in technical publications, and the relatively few articles addressed to the prospective purchaser usually close with some indefinite statement such as "Keep your eye on this thing. It has great possibilities and is going places." It would appear that an answer to the question, "Has the heat pump arrived?" might be of more practical value today.

Types of heat pumps

There are, among many others, three main sources of heat available for use by heat pumps—ground, water, and air. While it is true that the ground offers a potentially large source of heat, the initial cost involved in burying coils would be prohibitive. In addition, maintenance costs would be very high and, most important, the earth is a very poor conductor of heat. Thus, when the ground surrounding the coils became cold by the transfer of heat to the coils, either a method of replacing that heat by solar radiation or rain would have to be relied upon, or the coils would have to cover such a large area that, again, initial costs would be prohibitive.

The air-to-water type of heat pump is probably the most practical but local conditions determine if it is economically feasible. In certain areas, such as Florida, where it is only necessary to drill about twenty feet for a well, this type of heat pump has found great acceptance. However, in other areas, such as Washington, D. C., use of the air-to-water heat pump is virtually precluded because of the high cost of well drilling, high water rates, or a high sewerage tax on water that is thrown into the sewers. It might be mentioned that there is one such heat pump in operation in the Executive Pharmacy, 909 Pennsylvania Avenue, N.W. This heat pump has been providing heating and cooling for over fifteen years and is using well water at about 50° F.

Thus, the air-to-air type heat pump seems to be the answer, at least in the D. C. area. In fact, five leading manufacturers have sales offices and a dealer organization for the air-to-air package-type heat pump, and others expect to have the same type on the market in the near future.

Naturally, the first question that a prospective purchaser of a heat pump wants answered are: "Will it work?" "What's the initial cost?" "What are operating costs?"

Will it work?

The first question has already been answered and proof positive is given by the number of units now in successful operation, and by the number of sales of new units. Air-to-air heat pumps are being used successfully as far north as Indiana and New Jersey. One of the newest installations in Washington, D. C., using the 5-ton package heat pump is the Barber-Ross Company store and office building at 2323 4th Street, N.E. This building contains 18,000 square feet of floor area and is approximately 198,000 cubic feet in volume. It is a single-story structure of cinderblock and brick construction, with a concrete-slab floor. Sixteen 5-ton package heat pumps, arranged in groups of four, are being installed on the roof of the building. The two main reasons for this type of installation are:

1. The duct work which extends from the units through the roof and terminate in ceiling diffusers; hence the installation costs are held to a minimum.

Air-to-air package heat pumps installed on the roof of the Kensington Shopping Center, Kensington, Maryland.

2. The heating and cooling requirements for the store and office areas will differ, and this type of installation provides an inexpensive, yet efficient, method of zone control.

Another good example of the practicability of heat pumps is shown by the Kensington Shopping Center, in Kensington, Maryland. The original shopping center was a single-story building similar in construction to the Barber-Ross Company building described above, and consisted of seven stores. Ten package-type heat pumps installed on the roof have been in successful operation for almost one year. In fact, the owner of the shopping center has been so satisfied with the operation of the heat pumps that he is using this same means of heating and cooling for a seven-store addition to the original shopping center. This new building is now under construction and should be ready for occupancy before the end of the year.

What's the initial cost?

The initial cost of a heat pump is, in most cases, comparable to that of a conventional heating and cooling system. This is generally true in most commercial applications. At the present time, however, the initial cost for residential use could be as much as 10 to 15 percent higher than a conventional system. It should be pointed out that the cost of a heat pump should be compared to the combined cost of a conventional heating system and a conventional cooling system—not to the cost of a heating system alone. Furthermore, particularly in commercial buildings, the use of a heat pump can effect a real savings in initial constructional costs because it can usually be installed on the roof, in a penthouse, or at other locations outside the building. This saves valuable sales and production space in the interior. In addition, the heat pump does not require coal bins, fuel oil storage tanks, chimneys or flues, or a fire-proof boiler room, all of which add to the capital outlay for any given building.

Mr. Gilbert L. Seay, partner, Hayes, Seay, Mattern & Mattern, Architects & Engineers, stated in "Electric Heating and Cooling" magazine, 2nd quarter, 1957, as follows:

"Under certain conditions, the initial construction cost savings can result in up to around 10 percent of the air conditioning, heating and ventilating costs. It is doubtful if 10 percent savings could be appreciably exceeded. The heat pump is not economically feasible unless the user intends to both heat and cool his building or, as we say, completely air condition his building. Under these conditions in a new building requiring a cooling capacity not exceeding 300 tons, the heat pump will usually break even or be more economical in first costs than a boiler and a conventional cooling system."

The heat pump is also very well adaptable to old buildings that are being remodeled. The ease with which it can be installed, the factor of cleanliness, and the fact that it circulates more air at a lower temperature than a conventional heating system with less likelihood of cold and hot spots make it very attractive.

Furthermore, a leading manufacturer has stated that if sales continue to rise at the present rate, mass production of large quantities of heat pumps could reduce the initial installation cost as much as 40 percent in five years.

What are the operating costs?

Operating costs would have to be estimated for each individual case. In the case of residential applications of the heat pump, the Electric Institute of Washington has published in their "Standards For Heat Pump Installations in Residential Occupancies" the following:

"Based on these standards and contemplating normal operating conditions in this area and utilizing an electric rate of 1.71c per Kwhr., it can be expected that operating costs for heating will be comparable to those of automatic heating supplied by other types of fuel."

Operating costs can be quite easily calculated from the manufacturer's specifications once the heat loss and gain of a residence has been determined, and the inside design temperature decided upon.

Estimation of operating costs of a heat pump installed in a commercial building is somewhat more involved. The following is one method that has been used successfully in this area:

A reasonable estimate of the Kwhr consumption for cooling or heating is the product of (Kw input) × (number of hours of possible operation) × (an appropriate multiplier). Tables of output and Kw input for different outside temperatures are available from the manufacturer.

The number of hours of possible operation can be compiled from the summary of hourly observations contained in the U. S. Department of Commerce, Weather Bureau, Bulletin No. 30-50.

The multiplier will have to be estimated because the figure will vary for each geographical area and temperature range. In estimating this multiplier, the following should be considered:

The type of building involved. A larger figure would be necessary in the case of an apartment house or hospital having 24-hour operation, as compared to an office building that has only normal daytime occupancy and has its night load reduced by control of ventilation air during the off hours.

The actual outside design temperature. This figure, based on the internal heat gains, etc., when cooling or heating is needed, might vary for each building.

The total or actual time during the various temperature ranges when the heat pump may be required to function. Some intelligent estimate of this time must be made.

Another method for estimating operating costs is simply a direct comparison with a similar structure that is already using a heat pump. Most electric utility companies are separately metering all heat pump installations in their territory, and have compiled very reliable statistics on the Kwhr consumption and operating costs. Thus, in many cases, a direct comparison is quite easily made by use of these readily available figures.

It should be pointed out, however, that never should any of the above methods be taken as absolutely accurate. The living habits of the residential user, as well as the operating conditions in commercial establishments, are most important and will, along with the electric rates, always determine the actual operating costs.

Design considerations

The correct sizing of a heat pump for a given structure is of the utmost importance. First, the use for which the building is intended must be known. If the building is to be used as a residence the heating requirements will dominate; if the building is to be used in some type of commercial application the cooling requirements will normally govern. In most commercial buildings the amount of heat generated by the lighting, additional equipment of all types, and the normally large numbers of people that will occupy the structure will account for a large amount of the required heating, with the result that the heating load is relatively light and the cooling load, heavy. In fact, one drive-in restaurant in Hyattsville, Maryland, has a total connected load of 228 Kw for lighting, cooking and miscellaneous power. When the drive-in has a large number of people present the heat pump goes on its cooling cycle except during the most severe winter weather. Nevertheless, the heat loss and heat gain must be calculated for each heat pump application. The determination of heat loss is usually quite simple by use of the expression:

$$H_e = U\,A\,(T_i - T_o)$$

where

H_e = Heating capacity needed, and is equal to the heat lost under design conditions.

U = Heat transmission coefficient in watts per square foot per degree temperature difference. (1 watt = 3.413 Btu per hour.) Accepted values for the U factors for all types of building materials can be obtained from the ASHAE (American Society of Heating and Air-Conditioning Engineers) Guide or from the NEMA (National Electric Manufacturers Association) Manual.

A = Area of surface in square feet through which the heat is being lost.

T_i = Inside temperature (usually 75° F.).

T_o = Outside design temperature (0° F. for Washington, D. C.).

The heat lost through each type of surface exposed to a colder temperature is calculated by substitution in the above formula. Additional heat is lost through all cracks and openings. In some cases this heat loss due to infiltration is a little more difficult to calculate. There are various methods, such as the "crack method" given in the ASHAE Guide, for calculating this loss. However, a very good approximation of infiltra-

(Please turn to page 30.)

SHIP RESEARCH

By DICK RUMKE, CE, '57, MSE, '60

Picture yourself on a large ship. The time is dusk during the early period of the second world war. The location is a mooring deck in calm waters. Suddenly there is a sharp cracking sound, and the ship begins to settle fore and aft. The vessel has been split amidships. Such an incident occurred when a brand new ship that had only completed the builder's trials and was lying at a dock snapped in two. This was the SCHENECTADY, pictured on the cover, one of several vessels that broke in two in calm water.

But of course the loss of ships did not occur only in protected areas. An instance to the contrary was the failure of a T-2 tanker in open sea where the weather and sea were moderate. Fig. 1 illustrates the jack-knifed position assumed by the ship after failure. When the bow section veered to port, the bottom plating was completely severed. After the ship made port, an intensive investigation was undertaken to determine the cause of the failure. Fig. 2 pictures the aft portion being investigated.

Although these ships were not complete losses, inasmuch as they could be and were repaired, the time delay and loss of cargo seriously impeded the war effort.

Both of these ships were all-welded structures. This method of construction rather than riveting was utilized because of the shorter times required for fabrication and for training of welders.

1. Aerial view of failure of T-2 tanker in open sea.

Under all types of service, weather and loading conditions, welded ships have proved their efficiency, reliability and seaworthiness. The percentage of complete failures is small in relation to the total number of ships built. It should be noted that structural failures have also occurred in riveted ships.

The incidence of these failures prompted the Secretary of the Navy to establish a Board of Investigation to inquire into their causes. This Board consisted of representatives from the U. S. Department of the Navy, U. S. Coast Guard, American Bureau of Shipping, and the Maritime Administration. The investigations included the collection of such data as weather reports in the vicinity of disabled ships, temperature readings, type and loading of cargo, photographs of the fractured surfaces, and laboratory tests on the physical properties of the material surrounding the failed portions of the ships. The primary purpose of the Board was to develop remedial measures immediately to reduce the casualty rate for broken ships.

The first corrective action taken on all-welded ships was to place riveted crack arrestors strategically about all the ships. Studies that had been conducted verified the fact that where cracks occurred in riveted ships, the greater portion of them were stopped at a riveted or lapped joint, whereas in the all-welded ship the crack continued to propagate through the welded butt joint. Such a device served to stop the cracks before extensive damage occurred.

Further examination of the fractured areas disclosed chevron markings as can be seen in Fig. 3. It was possible, by noting the direction of the apexes of this herringbone pattern, to trace the fracture to its origin. Such a method of investigation enabled the inspectors to locate similar sources for fracture initiation when information from various ships was compiled. The most troublesome area as indicated by these studies was in the vicinity of the hatches. It

was noted that 25 per cent of all early fractures originated near a square hatch corner on the Liberty ship.

An applied research project was begun that undertook full-scale experiments on modified hatch corners. Such a project determined that hatches with rounded corners and more gradual changes in cross section near the corners could absorb far more energy before failure than the original design. The basis for the greater energy absorption power has been attributed to the ability of the modified design to yield plastically in critical regions.

Structural defects alone were not the only matters being studied. The material laboratories were constantly testing the material going into the ships and also that material taken from areas surrounding the cracks in failed ships.

2. Arrow points to origin of fracture in aft portion of T-2 tanker.

Tensile tests performed on this material indicated that it was suitable for the service intended. But, upon subjecting this same material to various energy tests, investigators found that the results were not as satisfactory. This was brought out by testing the material at various temperatures. The lower the temperature at test, the less energy was required to break the specimens. In fact, at some low temperatures the steel specimens cracked like glass without any indication of ductility such as necking in a tensile specimen.

With this information the Board reviewed the temperature data obtained from the fractured ships and noted that in some cases the cracks ocurred when the temperature was as high as 50° F. Steel specimens taken from these vessels were retested and the results correlated with the energy data previously gathered. Apparently, this steel had a transition range: at higher temperatures, above 70° F., the material would be ductile, but below 50° F. this same material would become brittle. Within the transition range between these two temperatures the steel would be part ductile and part brittle.

Chemistry then entered the picture. All the steels tested had carbon content of various percentages. In addition, the steels went through varying manufacturing processes. With this added knowledge correlated with data from fractured plates, the Board concluded that current specifications would have to be modified if brittle facture were to be avoided.

These wartime studies did not produce all the answers to ship structural failures. They did tend to reduce the casualty rate tremendously. Based on ship-years of service (the summation of service time for all ships of a given type). T-2 tanker failures were reduced from about 8 to 0.7 per 100 ship-years and Liberty ships from about 6 to 0.22 per 100 ship-years.

After the war, the Board of Investigation recommended the continuation of its research program. On this premise, the Secretary of the Treasury, in 1946, established the Ship Structure Committee to continue on a permanent basis studies directed toward the improvement of the hull structures of ships. This Committee is composed of one representative from each of the four previously named organizations and a representative from the Military Sea Transportation Service. Its sole aim is directed toward the improvement of the hull structures of ships. It is not a

(Please turn to page 28.)

3. Chevron markings of a fractured surface point toward origin of fracture indicated by arrow.

ALUMVIEWS . . .

President's Message

By ALFRED B. MOE

President, Engineers' Alumni Association

Another year has rolled around. School has been in session for several weeks and everyone has more or less settled down to his assigned task. Tompkins Hall, after a year's shakedown, has become a familiar landmark and is now recognized as "our engineering school." To make it all official, the first issue of *Mecheleciv* for 1957-1958 is off the press. Greetings!

The course of action for the forthcoming school year is fairly certain in most cases. The Dean and faculty will carry out the academic program expertly and efficiently. The students will be involved, in varying degrees, in extracurricular activities such as the Engineers' Council, Professional Societies, Theta Tau, Sigma Tau, publishing *Mecheleciv* and planning for the traditional events sponsored each year by the School of Engineering.

The alumnae will be involved, too, but with considerable uncertainty. Some will be ready with donations of time and/or money to help the school or the students in various ways. Others will be receptive towards assisting, provided they are notified. Still others feel that once they are out of school, the school has no further interest in them so, by the same token, they have little or no interest in the school.

The alumnae can make many valuable contributions to the School of Engineering. A subscription to *Mecheleciv* would help considerably. This fine magazine not only informs the alums of what the students, faculty, societies, and fraternities are doing, but should also, through a healthy "alum" page keep the graduates informed of where their old school mates are and what they are doing.

Then there is always the ugly question of money. If every "alum" donated a few dollars, much needed equipment could be obtained. Although Tompkins Hall is a fine new building with excellent class rooms and laboratory space, the training equipment itself leaves much to be desired. Modern theory is hard to explain and prove on ancient equipment.

Many alums are in a position where they could arrange for donations of electronic, electrical, or mechanical equipment to the school. A call to the Dean would provide the necessary information as to what is needed and under what conditions the school would like to receive donations.

Last but not least, the graduates could drop around once in a while and attend a few of the yearly events, renew old friendships with the faculty and other alumnae, and chat with the students. An article or two for *Mecheleciv* would also be welcome.

Yes, there are a number of things the ex-students could do. It would not involve a great deal of time or funds, but it certainly would benefit considerably those who are studying to be our future engineers.

Robert S. Babin, B.E.E. '47

ROBERT S. BABIN (B.E.E. '47) has joined the Technical Staff of the Communications Division, The Ramo-Wooldridge Corporation, Los Angeles. Prior to this move, Bob was Electronic Scientist for the U. S. Department of Defense, Washington, D. C. His work involved antenna and propagation research and communications systems development.

In addition to his work at G. W., Bob took post-graduate studies in communications engineering at the University of Maryland.

The editorial staff of *Mecheleciv* would like to extend their congratulations to Mr. Babin, a good friend and adviser via correspondence to the magazine.

ROY H. HEALD (B.M.E. '19, M.E. '21), a National Bureau of Standards aerodynamics expert, has been awarded the Department of Commerce Silver Medal for Meritorious Service. The award recognizes his "long and distinguished service in the field of missile acrodynamics."

Mr. Heald, a member of the Fluid Mechanics Section of the Mechanics Section of the Mechanics Division, is currently involved in the first wind tunnel study of the roll and yaw stability of finned missiles. These experiments were made possible by the development of a unique method by Mr. Heald for studying the behavior of missiles in horizontal wind tunnels at both subsonic and supersonic speeds.

ART PROCTOR (B.E.E. '53) has been employed by PEPCO since graduation. His work during the past year consisted primarily of providing adequate feeders and associated equipment for large buildings and shopping centers. Art was promoted to Associate Engineer, the management classification of the company, on May 15, 1957, one month before he had been with PEPCO four years. His latest pride and joy is a new 1957 Dodge Lancer.

Class of '57

PHILIP B. DOBYNS, Jr. (B.S.E. '57) is now an Engineer with John I. Thompson and Co. of Washington, D. C. His present duties involve technical writing. Friday, August 30, 1957, was a very important date for Phil inasmuch as that was the day he gave up his bachelorhood. The couple now reside at 1549 S. 28th Street, #3, Arlington, Va.

RONALD B. HOLLANDER (B.S.E. '57) was employed as an Industrial Engineer by Vitro Corporation in their Silver Spring Laboratory. The Air Force tendered their claim on Ronnie as of last September and he reported to Lowry Air Force Base, Denver, Colorado. A more recent card from the new 2nd John reports that the country out there is beyond description. Without further enlightenment we took that to be a favorable reaction on his part. Ronnie says that the life of an officer out there is not too hard but goes on to tell of going to school from 6 a.m. to noon. That 6 a.m. looks rough from here.

EDGAR L. DIX (3.E.E. '57) has been working on the design of a modulated transmitter for the earth satellite which uses transistors. He is an Electronic Scientist for the Naval Research Laboratory in D. C., has three children, and resides at 5013 Neptune Avenue S. E., Washington 21, D. C.

MORROW H. MOORE, Jr. (B.M.E. '57) is attending the California Institute of Technology on a Fellowship. This past summer Morrow was employed at the Diamond Ordnance Fuze Labs in D. C. If you would like to know about life at Cal. Tech, write to Morrow at Athenaeum, 551 South Hill Avenue, Pasadena, California.

ROBERT W. FULCHER (B.E.E. '57) is now on duty with the Air Force in California and is in for a three-year tour. Bob is on military leave from Vitro Corporation's Silver Spring Laboratory where he worked as an Electrical Engineer on missile systems and underwater techniques before answering the call.

EARL E. RESER (B.E.E. '57) accepted a position as Radio Communications Engineer with Motorola Communications and Electronics, Inc., upon graduation. Earl reports that he likes his job which consists of a little engineering and a lot of selling and provides excellent pay and benefits. The family enjoys Winston-Salem and living in civilization again. (Ed. note—Rebels, huh?) To find out if May was twisting Earl's arm when he wrote that last line, write to Earl at 2077 Queen Street, Winston-Salem, N. C.

JOSEPH A. GRELUNAS (B.E.E. '57) reported to the General Electric Company in Baltimore upon graduation. He is working as an Installation and Service Engineer and finds the work interesting and educational, with the emphasis on the practical side. The family, Mary, Margaret, and Elizabeth, are fine. Joe would like to have anyone passing through Baltimore drop in and see him at 5604 Haddon Avenue, Apartment A, Baltimore 7, Md.

FRANCIS MIKALAUSKAS (B.E.E. '57) reports that new little daughter, Joan Ellen, is doing quite nicely. The family recently moved to 4143 58th Street, San Diego 15, California. Mike works as a Design Engineer (Electronics) for Convair.

ROY D. BROOKS (B.E.E. '57) works as a Design Engineer for Crosley Division of AVCO Manufacturing Corporation. Roy narrowly escaped entering the service in September. It seems that the draft board in New Jersey (where his parents live) told him to report, so he quit his job and did so. It developed that the D. C. Board had Roy on *their* list and weren't quite ready to call him but insisted that he was their boy. In any event, they told Roy to go back to work and they would get in touch with him later. There are those who think Roy arranged this mixup so that he could attend Phil Dobyns' wedding in Arlington at the same time. For the straight scoop, try contacting Roy at Room 350, L. B. Harrison Club, 2368 Victory Parkway, Cincinnati 6, Ohio.

ARTHUR E. KOSKI (B.C.E. '57) still resides at 2303 N. 10th Street, Arlington 1, Virginia. He has continued as the Western Area Project Manager for Navy Family Housing, Bureau of Yards and Docks, U. S. Navy.

ALFRED W. RICHMOND (B.S.E. '57) has continued in his position as Intelligence Analyst for the Air Force in D. C. The Richmonds are expecting to bring child number 3 home to 4917 Aurora Drive, Kensington, Md. any day now. (Perhaps already have, since this information was furnished us last summer.)

JAMES E. SULLIVAN (B.S.E. '57) has started the Cutler-Hammer Inc. factory training program in Milwaukee. On completion of the course about the first of the year he expects to be assigned as a Sales Engineer to one of the district sales offices. Betty and Chip are reported as enjoying a wonderful summer and fall climate in the Northland. Information on Milwaukee's part in the World Series can probably be obtained first hand from Jim at 9820 W. Howard Avenue, Milwaukee 19, Wisconsin.

DAVID A. LEWIS (B.M.E. '57) absconded with one of fellow Democrat Senator Neuberger's most attractive employees during the summer. After legalizing the procedure with a marriage license, Dave carried the former Betsy Brown off to the wilds of Connecticut where they now live about ten feet from a lake and twenty miles from Pratt and Whitney where he works. Dave promises to pay his $2.00 *Mecheleciv* subscription after receiving this first issue. (We'll hold you to that, Dave. About a week after this issue is mailed, if we haven't heard from you we'll send a special bill to RFD #3, Cheney Lane, Coventry, Conn.) Apparently Dave is enjoying his work as an experimental Test Engineer for Pratt and Whitney, presently concerned with vibrations instrumentation.

DANIEL A. DREYFUS (B.C.E. '57) was married September 21, 1957. He is now with the Texas Company (Petroleum) as a Civil Engineer. Present address for the bride and groom is 403 E. 6th Street, Lockport, Illinois.

KENNETH T. CORNELIUS (B.M.E. '57) continues in his work as a Physicist at the David Taylor Model Basin and still resides RT 1318 35th Street, N. W., D. C.

TO: ALUMNI EDITOR

Mecheleciv Magazine
The Davis-Hodgkins House
The George Washington University
Washington 6, D. C.

From: _____

Here are a few comments for ALUMVIEWS on where I am working, what I'm doing and news of my family.

_____

_____

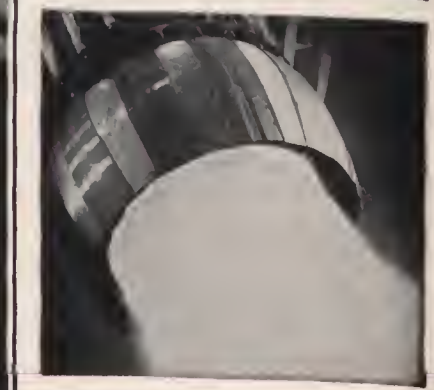
_____

_____

_____

Degree and Date _____ Fraternity _____

What's doing...



One indication of accomplishment in the combustion field: the J-57 engine, augmented by afterburner, provided the thrust which made supersonic flight practical for the first time.

This special periscope gives Pratt & Whitney Aircraft engineer a close-up view of combustion process actually taking place within the afterburner of an advanced jet engine on test. What the engineer observes is simultaneously recorded by a high-speed motion picture camera.

at Pratt & Whitney Aircraft in the field of Combustion

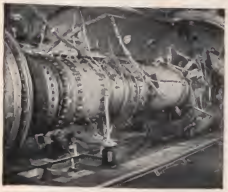
Historically, the process of combustion has excited man's insatiable hunger for knowledge. Since his most primitive attempts to make use of this phenomenon, he has found tremendous fascination in its potentials.

Perhaps at no time in history has that fascination been greater than it is today with respect to the use of combustion principles in the modern aircraft engine.

At Pratt & Whitney Aircraft, theorems of many sciences are being applied to the design and development of high heat release rate devices. In spite of the apparent simplicity of a combustion system, the bringing together of fuel and air in proper proportions, the ignition of the mixture, and the rapid mixing of burned and unburned gases involves a most complex series of interrelated events — events ocurring simultaneously in time and space.

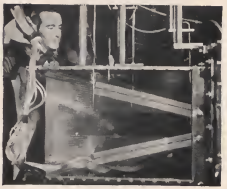
Although the combustion engineer draws on many fields of science (including thermodynamics, aerodynamics, fluid mechanics, heat transfer, applied mechanics, metallurgy and chemistry), the design of combustion systems has not yet been reduced to really scientific principles. Therefore, the highly successful performance of engines like the J-57, J-75 and others stands as a tribute to the vision, imagination and pioneering efforts of those at Pratt & Whitney Aircraft engaged in combustion work.

While combustion assignments, themselves, involve a diversity of engineering talent, the field is only one of a broadly diversified engineering program at Pratt & Whitney Aircraft. That program—with other far-reaching activities in the fields of instrumentation, materials problems, mechanical design and aerodynamics — spells out a gratifying future for many of today's engineering students.



Mounting an afterburner in a special high-altitude test chamber in P&WA's Willgoos Turbine Laboratory permits study of a variety of combustion problems which may be encountered during later development stages.

Microflash photo illustrates one continuing problem: design and development of fuel injection systems which properly atomize and distribute under all flight conditions.



Pratt & Whitney Aircraft engineer manipulates probe in exit of two-dimensional research diffuser. Diffuser design for advanced power plants is one of many air flow problems that exist in combustion work.

World's foremost designer and builder of aircraft engines

PRATT & WHITNEY AIRCRAFT

Division of United Aircraft Corporation

EAST HARTFORD 8, CONNECTICUT

School of Engineering Honors List

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Spring Semester 1957

Mecheleciv takes great pleasure in commending the following students for achieving the School of Engineering Honors List for the Spring Semester of 1957. Each of these students has satisfied all of the following requirements:

(a) The student's cumulative quality-point-index is equal to or exceeds 3.00.

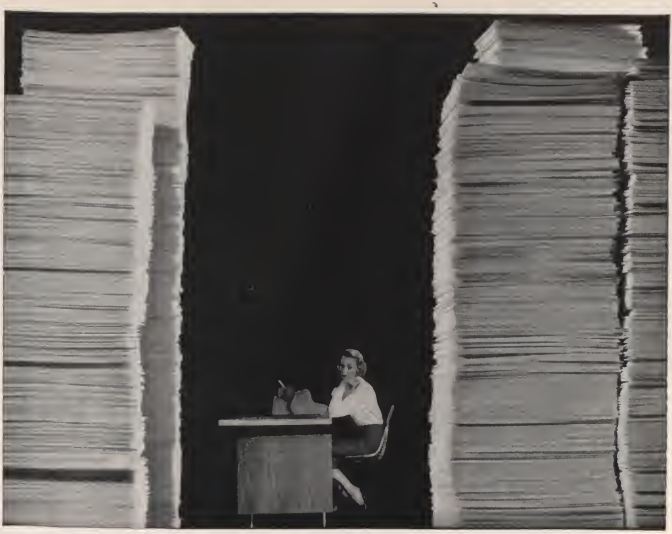
(b) At least 30 semester hours credit has been earned as a degree candidate in the School of Engineering.

(c) At least 15 (part-time student) or 30 (full-time student) semester hours credit in an engineering degree curriculum has been earned in the immediate two consecutive semesters.

(d) No grade below "C" has been received during the qualifying period stated in (c) above.

(e) No disciplinary action has been taken in respect to the student.

Al-Mallah, Moyassar Y.
Barnes, Laurence A., Jr.
Barranger, John P.
Beck, Henry D.
Beuttenmuller, Richard A.
Clamons, Ormond L.
Davis, Wayne A.
Dietz, Stephan K.
Dreyfus, Daniel A.
Grossman, Ronald A.
Hall, Stanley R.
Havens, Daniel B.
Joyce, James W., Jr.
Joyce, John D.
Kaminetzky, Jerry
Kenyon, Randall C.
Kransdorf, Ronald J.
McChesney, Donald W.
Malasky, Carl R.
Mayo, Henry C.
Meltzer, Arnold C.
Moore, Morrow H., Jr.
Moore, Robert Milton
Perschy, James A.
Potterton, Richard L.
Redden, Miller Stuart, Jr.
Renton, Gerald W.
Sapardiman, Soeseno
Schuler, Bernard C.
Trask, David K.
White, David M.
Williams, John H., Jr.



WORLD'S LARGEST ELECTRONIC BRAIN

RCA BIZMAC reduces weeks of paper work to seconds—cuts costs by millions!

In almost the twinkling of an eye, electronics handles calculations that would take any person days of work.

The newest – and largest – electronic "brain" (more accurately, electronic data processing system) is Bizmac, developed by RCA.

Bizmac is quickly becoming one of the most powerful allies of business and industry. It "reads," sorts, catalogs, analyzes, calculates, forecasts—reduces months of paper work to seconds—cuts costs by millions!

For insurance companies, Bizmac can keep its finger on millions of facts daily. It can help department stores keep split-second inventory control. And for the U. S. Army, it keeps track of literally *billions* of ordnance parts all over the world.

The leadership in electronic research that made Bizmac possible is inherent in all RCA products and services—to help make life fuller, easier, safer through "Electronics for Living." TKK(o) ®

WHERE TO, MR. ENGINEER? RCA offers careers in research, development, design, and manufacturing for engineers with Bachelor or advanced degrees in E. E., M. E. or Physics. For full information, write to: Mr. Robert Haklisch, Manager, College Relations, Radio Corporation of America, Camden 2, N. J.

RADIO CORPORATION OF AMERICA
ELECTRONICS FOR LIVING

CAMPUS NEWS

Angela Tehaan
Homecoming Queen Candidate
Theta Tau

Engineers' Council

The Engineers' Council got an early start in activities this year by participating in the University Summer Carnival in July and by holding the Fall Engineers' Mixer on September 17.

The Engineers' booth at the Summer Carnival consisted of a "Kissometer" which was resurrected from the basement of the Davis-Hodgkins House and renovated by Norm Street and Phil Pendleton. The booth supposedly indicated the intensity of osculation of the daring couples who were willing to demonstrate their skill in front of the large group of people who hung around in the vicinity of the electronic marvel during the evening. The quality of each couple's performance was indicated by a series of lights, horns, and an electric arc snapping off the end of a Jacob's Ladder. The accompanying picture shows Barker Phil Pendleton and Woody Everett watching Engineers' Council President, Vince Rider, and his wife, Jean, in action. The light at the top left-hand side of the board was lighted when this picture was taken. A second later the arc started between the electrodes behind the plexiglass window at the top of the device. Those hardy souls who could keep the arc going for approximately five seconds were rewarded by the automatic sounding of a horn behind the panel. The booth wasn't one of the big money-makers of the midway but was far and away the biggest attraction at the carnival.

The Engineers' Mixer, organized under the capable direction of Irv Schick, was also a resounding success. The featured attraction of the show was a magician, Wiseman the Wizard. The high point of his performance came when attractive Ann Atkins, one of the new freshmen, was acting as Wiseman's assistant. Ann reached into his magic bag, expecting to pull out a piece of rope when, much to her embarrassment, she came out with an item of feminine apparel.

Phil Pendleton is doing a bang-up job as House Manager of the D-H House. In addition to keeping the upper floors shipshape and getting a new coke machine installed, he has been working diligently to make the basement space usable. A new TV lounge is practically finished in the front room of the basement and the kitchen has been cleaned up and is being made suitable for use by student groups.

The Council assisted with the registration procedure and their efforts seemed to be appreciated by both the students and the faculty.

Your support is encouraged in the new "Litterbug" campaign to keep Tompkins Hall clean and in good shape. Please do not throw waste paper and cigarette butts around on the floor. Containers are provided in the halls for trash.

Claire Lee Chenault
Homecoming Queen Candidate
Engineers' Council

Engineers' Kissometer

Homecoming

This year two of the School of Engineering student groups are entering candidates for Homecoming Queen. The Engineers' Council is pinning their hopes on Claire Lee Chenault, Junior Engineering student. Theta Tau is offering competition in the form of Angela Tehaan, Sophomore student in the Junior College. The first judging will take place in the Sigma Alpha Epsilon Fraternity house on the afternoon of October 31st. The judges will be Eddie Gallagher, local disc jockey, Phyllis Bell of Phyllis Bell's Model Agency, and a third judge yet to be selected. The five finalists will be announced at the pep rally on the evening of Oct. 31st and will also be presented during the half at the Homecoming Game at Griffith Stadium on Nov. 1. The queen will be selected by vote of the student body on Nov. 1. A voting booth will be set up in the lobby of the Student Union. It would be a feather in the cap of the School of Engineering if they could help elect one of their candidates to the queen's throne. Watch for the announcement of the finalists and let's all get out and vote. The winner will be announced at the game and crowned at the Homecoming Ball in the Armory on Nov. 2. Tables are reserved at the Ball in the name of Theta Tau for the use of any Engineering students.

AMERICAN SOCIETY OF CIVIL ENGINEERS

The Student Chapter of A. S. C. E. is planning a full and varied program for the semester. The aim of the Society is to give the student engineer that which he cannot get in the classroom—an insight into various applications of engineering practice, as well as a broader look at his future in the engineering profession. The October meeting was an introduction to the Society, and also included a movie. The Chapter is currently conducting a membership campaign aimed at both civil engineering students and BSE candidates. Also, chapter president Dick Haefs announces the appointment of Dr. Robert Hechtman as the new faculty advisor.

A. S. M. E.

The George Washington University Branch of the American Society of Mechanical Engineers plan to have an active program for the year. They will have speakers who will be able to enhance the students' engineering education and development.

All of the meetings will be held at 8:00 p.m. on the first Wednesday of each month. The opening session was held on October 2, 1957, and the principal speaker was Mr. De Witt Fulton of the Westinghouse Electric Corporation.

The student branch will present outstanding speakers on engineering subjects covering research, development, design, and application; it will also present student speakers who will compete for local and national prizes. The local student branch awards $60.00 in prizes for the best three papers presented by student ASME members.

AIEE-IRE STUDENT BRANCH

The Joint Student Branch of the AIEE-IRE began its 1957-58 season with a bang! Eighty-six new members joined the branch during registration week, and twenty-eight joined as student members in the National organizations.

At the first meeting, held on Wednesday, October 2, 1957, over fifty members turned out to give a well deserved "welcome home" to AIEE Faculty Advisor Professor Norman B. Ames. Professor Ames, who spent the past year as a Fulbright lecturer in Ceylon, presented a fascinating and interesting talk on the country of Ceylon and its engineering problems. We're all glad to have you back, Deacon, and hope that you'll be around for a long time.

The next meeting will be held on the first Wednesday of November at 8:30 p.m., in Room 200, Tompkins Hall. The Potomac Electric Power Company of Washington has made arrangements for Mr. J. G. Yevick of Atomic Power Development Associates, Inc., to come from Detroit and present a talk on atomic power developments. Mr. Yevick worked for four years as an engineer on the development of the nuclear reactor power plant for the submarine "SEA WOLF", and is currently working on the development of the nuclear reactor being built in Detroit by the Atomic Power Development Association for the generation of electric power. His lecture will be augmented with a plastic model of this reactor. The Joint Student Branch urges all members to make plans now to attend this November 6 meeting. It should be both interesting and informative, and a highlight of our 1957-58 season.

THETA TAU

The brothers of Theta Tau held regular meetings through the summer and thereby got a running start on the school year. A family picnic held during the first week of June at Fort Hunt enabled the graduating brothers to get together with the group for one last time before scattering to jobs in other parts of the country. The pledge picnic, held during the latter part of the summer at Fort Foote, was enjoyed by a good turnout of actives and prospective pledges. Chef Norm Street reigned over a regal repast of hamburgers, hot dogs, roast corn, watermelon, and ye olde wet, cold, and delicious. The picnickers almost suffered casualties when both Dick Pronck and pledge Vic Weiner skidded over the edge of the cliff-like river bank in pursuit of a wayward volley ball and tumbled seventy-five feet or so before being stopped by the underbrush. Putting in a call for a rescue squad complete with mountain climbing gear to bring out the bodies was considered but both men managed to scramble to the top unhurt except for a few scratches, bruises, and poison ivy rashes.

A beer bust was held at "Deacon" Ames' house on September 27 to welcome in the new school year. The night turned out cold and clear but the brothers were kept warm internally by delicious barbecue sandwiches prepared by Mrs. Ames and daughter, Phyllis, and externally by warming one side at a time at the fire or by engaging in a strenuous but inept game of volley ball.

The Fall Initiation was held in Studio A of Lisner Auditorium on the afternoon of October 12th during which the following pledges were initiated: Jim Lear, Jack O'Neale, Jim Linn, Woody Everett, John Roberts, Frank Narr, and Vic Weiner. The Banquet and Ball, organized by Rex Boothe and his committee, was held the same evening in the Magnolia Room of Hunting Towers Apartments.

There's an engineer's

● Western Electric has major manufacturing plants located at Chicago and Decatur, Ill., Kearny, N. J., Baltimore, Md., Indianapolis, Ind., Allentown, Pa., Winston-Salem, N. C., Buffalo, N. Y., North Andover, Mass. Distribution Centers in 30 cities. Installation headquarters in 16 cities. General headquarters: 195 Broadway, New York, N. Y. Also Teletype Corporation, Chicago 14, Illinois.

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● In the course of their technical work, engineers participate in such broad managerial functions as production, merchandising, installation, and many others. What's more, we have a record of promotions from within. It's not surprising, therefore, that fifty-five percent of the college graduates in our upper levels of management have engineering degrees.

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● The new engineer moves into the first phase of this program, **Introduction to Western Electric Engineering**, four to six months after he joins us and devotes nine weeks of study to such technical subjects as communications systems, military electronic systems, product design principles. He takes part in the second phase, **General Development**, after the first year on the job. In this phase he devotes nine weeks to courses in human relations, semantics, engineering statistics, electronics, measurements and instrumentation, systems circuit analysis. The third phase, **Advanced Development** (4 weeks per year), is available to selected engineers and is geared to the individual to help develop his creative engineering abilities; goes deeply into such subjects as magnetics, computer applications, electronic switching, radar fundamentals, feedback control systems and technical paper writing.

● Besides this company-wide program, a number of our divisions offer individual engineering courses in their own specialties. We also sponsor a Tuition Refund Plan for out-of-hours study at nearby colleges. Open to all employees, this plan helps our engineers study for advanced degrees at Company expense.

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For further information write: Engineering Personnel, Room 1030, 195 Broadway, New York 7, N. Y.

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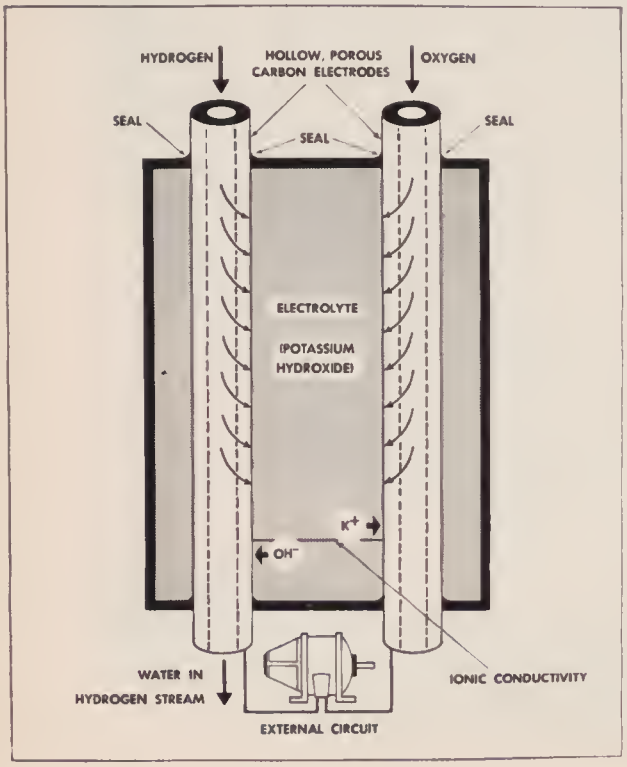
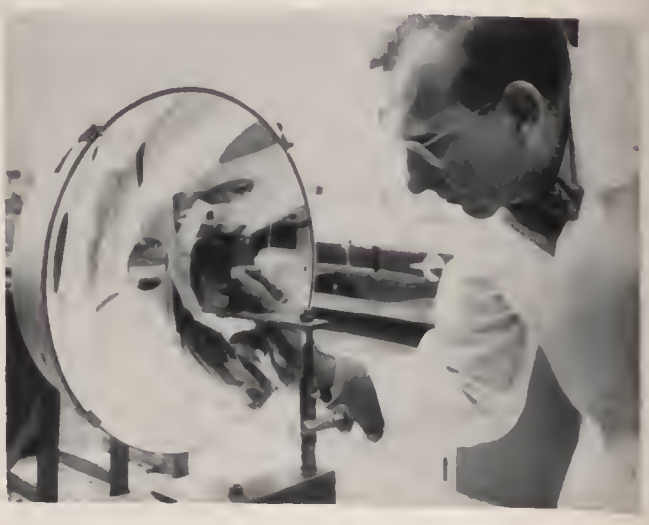
NEWS IN INDUSTRY

Electricity From Gases

It is now possible to directly convert the chemical energy of gases into electricity. A development of National Carbon Company, the new fuel cell economically produces thousands of watts. The drawing illustrates the basic operation of the cell. Hydrogen and oxygen gases enter the cell through specially-treated, hollow porous carbon electrodes. The gases diffuse to the surface where they come in contact with the electrolyte, a solution of potassium hydroxide. At the hydrogen electrode, the electrochemical reaction releases an electron, which flows through the external circuit and is accepted at the oxygen electrode. This flow of electrons is the current that powers electrical equipment. Ionic conductivity through the electrolyte completes the circuit, and the water formed in the reaction passes from the cell in the hydrogen stream. Water is the only by-product and is disposed of by evaporation. The life of the fuel cell is theoretically unlimited.





Movie Mirrors Duplicate Sun's Heat

Using two elliptical mirrors of the standard type found in motion picture projectors, the National Carbon Company has produced temperatures of 7,000 degrees F. The carbon arc which is used as a heat source draws 200 amps at 80 volts. Work has begun to produce arc image furnaces of still higher power. A shutter can be used to control the energy without disturbing the arc. A tilted mirror can be used to tilt the beam to any desired angle. The beam can be projected into a closed vessel through a transparent window if atmospheric control is necessary.

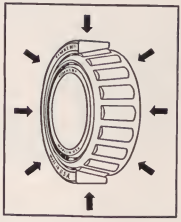
The picture shows a small crucible made of an experimental high-temperature material positioned at the short focal point of a highly polished mirror where it will be heated to incandescence by the energy beam from a carbon arc lamp. The lamp can be seen reflected in the mirror, immediately behind the technician's hand, and is lined up on the axis of the mirror.

Seconds after being exposed to the high-energy beam of the arc image furnace, a piece of high-temperature fire brick begins to melt and the molten material literally flows from the crater. Only materials that are capable of absorbing the radiant energy of the beam can be heated. A shiny object with good reflectance would remain relatively cool, while a black body would become extremely hot.

Tear out this page for **YOUR BEARING NOTEBOOK...**

How to lick a mixing problem

IN designing the bearing mounting for the drum axle of this heavy-duty mixer, the engineers had to consider the punishing radial and thrust loads as the drum rotates at an angle. And heavy shock loads from the impact of driving on rough roads had to be considered, too. To handle these loads simultaneously, keep the drum shaft aligned, the engineers specified Timken® tapered roller bearings. Result —free rolling, longer life, less maintenance.



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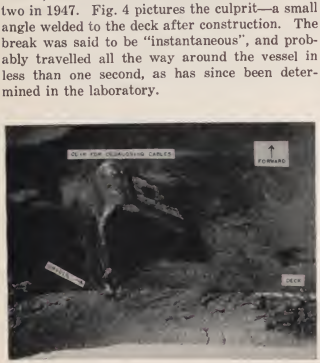
SHIP RESEARCH

(Continued from page 15.)

specification-writing group but one engaged solely in research and the dissemination of research results.

Based on the groundwork laid by the Board, the Committee was able to arrange a program comprised of design, materials and fabrication. In order to have available the advice of men from as broad a field of pertinent technical knowledge as possible, the Ship Structure Committee sought the assistance of the National Academy of Sciences-National Research Council for guidance of the design and materials portions of the overall program. On this basis, the Academy-Research Council created two committees: the Committee on Ship Steel and the Committee on Ship Structural Design. Through these committees some fifty of our nation's leading scientists and engineers, outstanding in fields related to structures and metallurgy, contribute freely of their technical knowledge.

Although the fundamental design of a ship is of the utmost importance, the Ship Structure Committee has also been faced with the problem of making it easier for the ship operators to prevent ship crews and ship repair yards from making dangerous minor alterations to the hull portion. These people cannot treat their ship in the same fashion that a homeowner treats his home, such as putting a bracket here or making a new door there. A striking example is a T-2 tanker, the PONAGANSETT, that snapped in two in 1947. Fig. 4 pictures the culprit—a small angle welded to the deck after construction. The break was said to be "instantaneous", and probably travelled all the way around the vessel in less than one second, as has since been determined in the laboratory.



This type of fracture is not unique to ships. Similar failures have occurred in other steel structures, such as pipelines, bridges, penstocks, and water towers. Fractures that have been caused by low temperatures, irregularities and low applied stresses have been termed brittle fractures. Such fractures can also be demonstrated through use of liquid oxygen, which exists at atmospheric pressure at a very low temperature. (The forming of a hammer from liquid mercury and actual driving of a nail with the frozen mercury can demonstrate this low-temperature property of liquid oxygen.) Brittle fracture at low temperature can be observed through the pouring of liquid oxygen over soft pliable rubber and the sudden shattering of the frozen rubber when dropped.

Thus, the problem for the Ship Structure Committee has been determined. The answers are now being sought. The design portion of this program has for several years carried out work in brittle fracture mechanics to determine various aspects of crack initiation and crack propagation. A long-term fundamental study of the structural design of ships has recently been initiated.

The three current regions of study within the materials research field concern (1) the quality of ship-plate steels now being produced, (2) the future improvement of commercially produced steels, and (3) the metallurgical fundamentals of brittle fracture.

The development and introduction into ship construction of designs and techniques that can reduce the incidence of structural failure together with the detection and evaluation of flaws have received considerable attention in the fabrication portion of the Ship Structure Committee research program.

To assure our nation of a safe, economical and dependable merchant marine not only in war but for such crises as the tanker shortage during the recent closing of the Suez Canal, it is imperative that research in ship structures continue.

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(Continued from page 13.)

tion can be obtained by making an intelligent estimate of the number of air changes per hour. Then:

$$H_a = N_c \, V \, (.37)$$

where

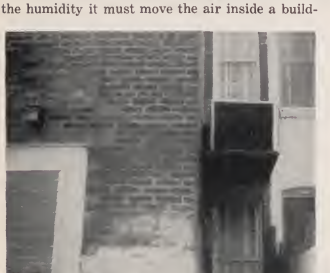
N_c = Air changes per hour.

V = Volume of building in cubic feet.

(.37) = Heat loss in watts per cubic foot of air per hour.

In residential applications an assumption of one air change per hour is generally considered adequate, provided the house has storm protection on all windows and doors and is well insulated. In commercial applications each building and its intended use must be considered separately. For example, in most communities the minimum amount of fresh air that is introduced into a restaurant is fixed by law.

Calculation of the heat gain of a building presents more of a problem. The effects of solar radiation and the latent and sensible loads must be considered. The ASHAE Guide gives a very complete and detailed method of calculating cooling loads, and, in addition, many manufacturers have prepared simplified methods that give very excellent approximations. Some of these methods use a type of slide rule, while others use prepared charts. Whatever method is used, the most important factor is that the cooling system be correctly sized according to the cooling load. Proper air conditioning requires not only the lowering of the inside temperature, but also the lowering of the relative humidity. Electric Institute of Washington Standards require a temperture of 76°-80° F. with 50% relative humidity when the outside temperature is 95° F. dry bulb. In order for an air conditioning unit to lower the humidity it must move the air inside a building over the condenser coils so that some of the moisture in the air is condensed. In other words, the unit must run. If the unit is over-size, the temperature of the delivered air will be so low that the inside temperature will be lowered very rapidly and the thermostat will shut the unit off before a sufficient amount of air is passed over the condenser coils to appreciably lower the humidity. This accounts for the cold, clammy, uncomfortable feeling that is sometimes encountered.



Two-ton heat pump installed at ceiling height in row house.
Photo courtesy PEPCO

All air-to-air heat pump installations have what is known as a balance point. That is the outside temperature below which the heat pump is not able to furnish the amount of heat required for a building, and therefore, some auxiliary type of heat (usually electric resistance strip heaters) must be used to make up the deficiency. Normally, very little, if any, supplemental heat is necessary in most commercial buildings because of the internal heat gains from lighting, other equipment, and people (one person, sitting, gives off about 400 Btu/hr). However, in residences the balance point, and hence the amount of supplemental heat required, is very important and has a direct bearing on the operating costs. "Standards for Heat Pump Installations in Residential Occupancies" published by the Electric Institute of Washington, states the following:

"*Design temperatures*—Winter: Outside temperature 0°; Inside temperature 75°. Summer: Outside temperature 95° dry bulb, 78° wet bulb; Inside temperature 75°.

"Capacity of heat pump equipment should be based on a balance point of 25°.

"*Insulation*—Regardless of the type of fuel, insulation is extremely important in reducing operating costs for any heating or cooling operation as well as in providing increased comfort both in winter and in summer. For heat pump installations, the following recommended minimum insulation shall be provided:

"Ceiling 4"*; Exposed walls 2"*.

"Floors—over unheated crawl space, 2"*.

—slab floors—perimeter insulation 2"*.

"Insulation shall be so installed as to place vapor barrier toward heated area.

"*Doors and windows weather stripped*—Storm sash or double pane glass can reduce heating cost by as much as 15% and is strongly recommended, especially on large glass areas."

[*Glass, wool or equivalent—with vapor barrier.]

Provided a building is properly insulated and the heat pump is properly sized so that its balance point is 25° F. or lower, it should give satisfactory and efficient service. A five-year aver-

age, from March 1950 through February 1955, of Weather Bureau data reveals that in the Washington, D. C., area there were only 163 hours during the heating season when the temperature fell below 25°, and only 59 hours when the temperature was below 20°. Thus, if a heat pump installation has a balance point between 20° and 25°, except for the defrost requirements, the supplementary heaters would be seldom, if ever, used because most of the hours below 25° F. occur during the night.

CONCLUSION

Almost every leading manufacturer of air conditioning equipment has a heat pump on the market, and the fact that this is a practical piece of equipment is evidenced by its popular acceptance. At the present time in the D. C. area there are about 73 package-type air-to-air heat pumps, both commercial and residential, installed. An additional 56 have been sold and will be in operation very shortly.

In considering the different types of heat pumps on the market and those that have been in operation in this area, there seems to be no doubt that the air-to-air type heat pump is indeed a practical unit, available to the home owner or commercial builder today. Provided each installation is engineered properly, and complies with standards such as those established by the Electric Institute of Washington, there is no reason why it should not give satisfactory and economical service. In most cases, its initial cost and cost of operation will be comparable to or less than those of a conventional heating and cooling system.

Every heat pump installation must be individually engineered. Many public utility companies, including the Potomac Electric Power Company, provide the services of competent and experienced heating and air conditioning engineers as well as endorse certain minimum standards to assist the prospective purchaser.

Has the heat pump arrived? Very definitely, Yes! It has been proven that the heat pump can compete economically with other types of automatic heating and cooling systems. In addition, the heat pump has many advantages over conventional systems. Since it burns no fuel, there is no soot; hence; it is much safer and cleaner than fuel-fired equipment. The comfort and convenience of a heat pump cannot be equaled. A thermostat, set at any desired temperture range, will activate the controls which take over and maintain that pre-selected temperature winter and summer. The heat pump has not only arrived, it is here to stay.

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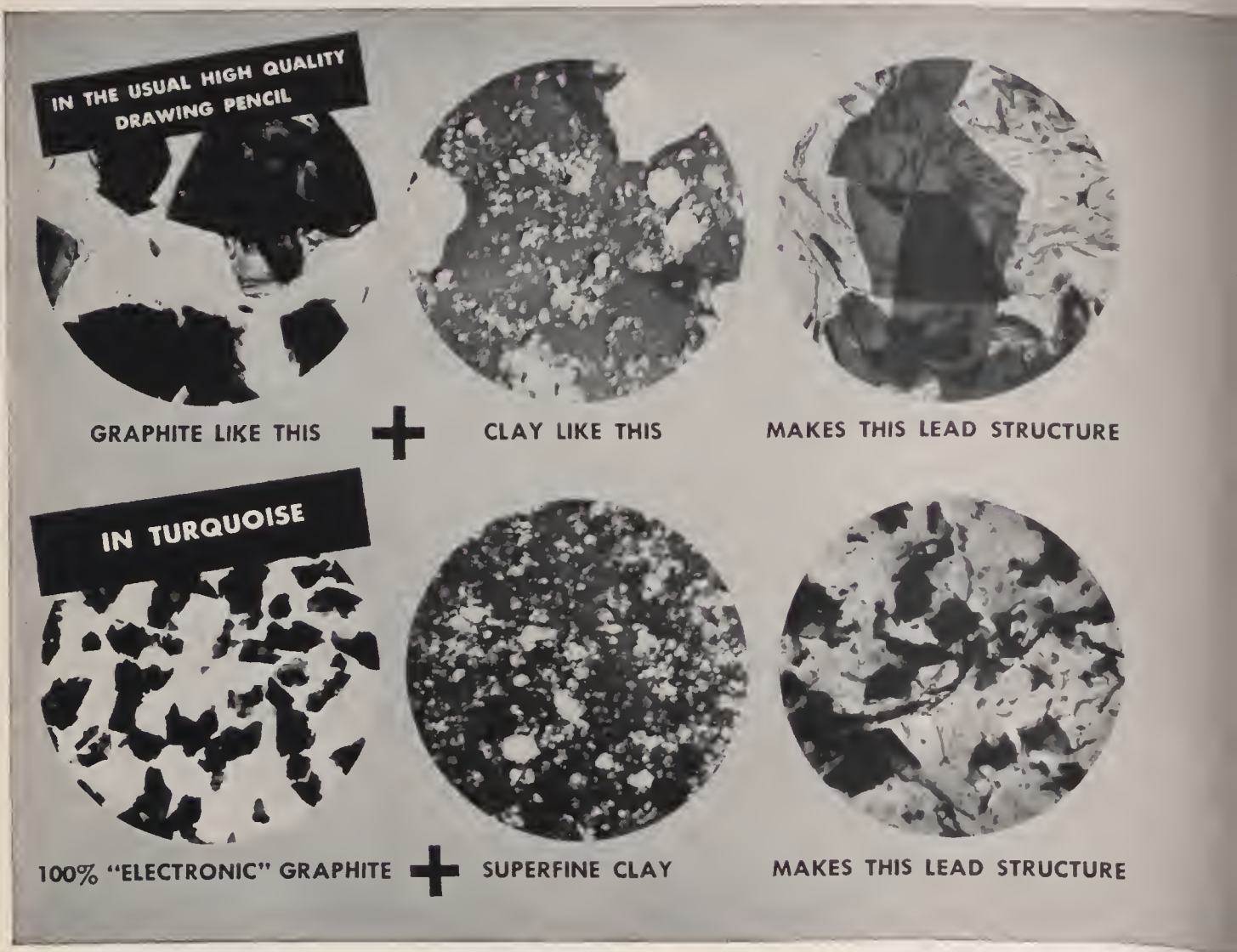

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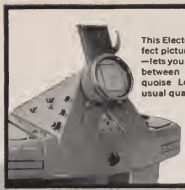
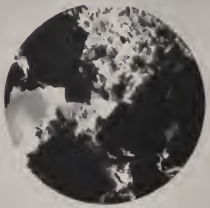


This Electron Microscope takes perfect pictures 7,500 times actual size—lets you see the startling difference between Eagle's "Electronic" Turquoise Lead and the lead in the usual quality drafting pencil.

Photographs courtesy of Ladd Research Industries, Inc.



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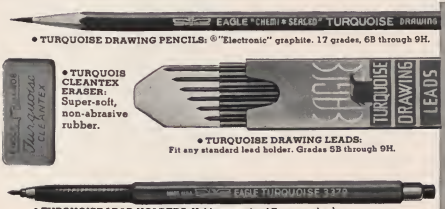

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COUNCIL

(Continued from page 10.)

The two member fraternities of the Council provide further service and social events for those students qualified. Theta Tau has 24 active chapters in the country and is the largest professional engineering fraternity in the world. Those students who have a QPI high enough by the time they reach their Junior year may be invited to become members of Sigma Tau, the National Honorary Engineering Fraternity on campus. Membership in these fraternities is by invitation.

The Council is also responsible for two publications: *Mecheleciv* which is your student-operated engineering magazine; and the *Engineers' Guide* designed to acquaint the students with organizations, regulations, and history of the School of Engineering.

For those people interested in any of the many phases of publishing a magazine, we have *Mecheleciv* which has a wide variety of staff positions available. There is always a need for new staff members. Being on the staff affords excellent opportunities for students to keep up-to-date in campus matters. The experience gained in the many departments (editorial, advertising, circulation, and business) of the magazine is another of the many ways possible to gain the qualities so important in becoming a good engineer.

Further information as to history, functions, and qualifications for joining the engineering organizations and societies may be found in the *Engineers' Guide*.

In your last two semesters one of your prime objectives will be to find employment. This is easily accomplished because of the demand for engineers. About all that is necessary for you to do is sign your name on one or more of the interview sheets provided by the Student Placement Office. These sheets list the interviewing company, the date, and time of interview. They will be found on the large bulletin board in the Davis-Hodgkins House. There will be several company representatives at the University from the beginning of the fall semester well into the spring semester. Watch the bulletin board and the Hatchet for the time and place for an interview with the company of your choice.

Some engineering graduates have started at higher salaries than others because they had a record of active participation in student body groups. Remember, your education is not complete with an engineering degree alone. Therefore, help yourself and your school by taking an active part in as many activities and organizations as possible.

MATHEMATICS

(Continued from page 9.)

overcrowded curriculum, there is no way to add courses without deleting others. It is simple arithmetic. You can't add 3 to 140 and get 140. You must add 3, subtract 3 and then you might get 140 again. The big problem is the 3 you must subtract. Physics, humanities, engineering science, and enginering major all have important places in the curricula along with mathematics. Representatives of each of these areas will argue that in any given engineering curriculum, there is not enough of their particular field.

There is an argument that much mathematics is taught in conjunction with regular engineering courses. This is certainly true and this extra mathematics is indispensible but still leaves some severe gaps in the overall mathematical knowledge required of the modern engineer. There is an argument that not everyone has the interest to take more mathematics, and there is much to be said for this. On the other hand there are some who feel that they need more mathematics than normally given in the standard engineering curriculum. Of course a student who really wants to get a great deal of mathematics may transfer or take the BSE with option in mathematics. This leaves the BCE, BEE, and BME student who feels that he would like to take a bit more mathematics. He cannot take mathematics as an elective since the electives are to be non-technical. To take extra mathematics courses to get those topics in which he is interested probably means four extra courses for which he has neither time nor money. It would be obvious that a man does not have to take six hours of the theory of functions of a complex variable to learn about conformal mapping and transform calculus. Likewise there should be no need to take a three-hour course in analysis or advanced differential equations to learn something about Bessel and Hankel Functions. The same thing could be said of about a dozen or more unrelated mathematics topics.

Recognizing the need among some students for additional mathematics work, Mr. Neely F. (Sy) Matthews, Instructor in Electrical Engineering, and myself have discussed the problem and have brought forth a proposal. The proposal is that there be set up within the unofficial structure of the School of Engineering, a club devoted to the discussion and study of advanced applied mathematics. We invite the opportunity to discuss your ideas and ours. Please watch the bulletin board outside of Room 314, Tompkins Hall, for further announcements. We sincerely hope that many of you will want to participate.

howard hughes fellowships

Ten awards are open to candidates interested in studies leading to a Doctor of Philosophy or Doctor of Engineering degree or in conducting post-doctoral research.

Each Fellowship provides a cash award of not less than $2000 . . . a minimum salary of $2500 for summer or part-time work . . . up to $1500 for tuition, books, and research expenses . . . and moving and transportation costs. Eligibility is based on the completion of one year of graduate work in physics or engineering, and qualification for graduate standing at California Institute of Technology, University of California (Berkeley), or Stanford University. Application closing date: January 15, 1958.

master of science fellowships

One hundred awards are open to participants who will complete courses leading to the Master of Science degree within 2 academic years. Tuition, admission fee, and books will be provided. During the summer they will have the opportunity to work with experienced Hughes scientists and engineers, while receiving salaries based upon their ability and technical experience.

Applicant must receive his B.S. degree during the coming year in Aeronautical Engineering, Electrical Engineering, Mechanical Engineering, or Physics. Participant may request his graduate school from the following six institutions: University of Southern California, UCLA, Stanford University, University of Arizona, Purdue University, or West Virginia University.

Write, specifying appropriate fellowship, to:
Office of Advanced Studies

HUGHES

RESEARCH AND DEVELOPMENT LABORATORIES

Hughes Aircraft Co., Culver City, Calif.

SLIPSTICK SLAPSTICK

A man never knows if he likes bathing beauties until he's bathed one.

Sign in machine shop: "Girls, if your sweater is too large for you, look out for the machines; if you are too large for the sweater, look out for the machinists."

"You missed class yesterday, didn't you? "
"No sir, not a bit."

First Little Boy: "I don't like that new girl in the block. Her neck's dirty."
Second Little Boy: "Her does?"

Dear Pop:
Everything fine at school. I'm getting lots of sleep and am studying hard. Incidentally, I'm enclosing my fraternity bill.
Your son,
Pudge

Dear Pudge:
Don't buy any more fraternities.
Your Pop

Pilot to Navigator: "Where are we?"
Navigator to Pilot: "By using my extensive knowledge of calculus and trigonometry, I have calculated our position to be three miles from infinity."

"What steps would you take in determining the height of a building using an aneroid barometer?" read a question in a C.E. exam.
One student short on knowledge but long on ingenuity replied: "I would lower the barometer on a string from the roof and then measure the string."

At a sales meeting the district sales manager said he wished to present nylons to each man to give to his wife. The men were asked to give their wive's sizes. After they had given their sizes, a change in the plan was announced. Instead of giving them directly to the men, the Sales Manager decided to deliver them to the wives. Four of the men stepped up and each said, "Change my wife's size from 8 to 10."

Soph.: "I failed my Physics exam."
Jr.: "But I thought you had the answers written on your cuff."
Soph.: "Yeah, but by mistake I put on my Calculus shirt."

An engineer caught his girl in a fraternity brother's arms. To their startled expression he calmly replied: "I don't mind if you neck with my girl, but there is going to be one peach of a fight if you don't take your hand off my fraternity pin."

M. E.: "Whisper those three little words that will make me walk on air."
Coed: "Go hang yourself."

"Let's organize a fraternity."
"Why?"
"I've discovered a new grip."

Sign on the bank of a Texas farmer's fish pond: "No Fishing Allowed. Survivors Will Be Prosecuted."

A Russian widower, after spending a number of years in France, returned to Russia. A cautious man, he left behind his son and five-year-old daughter Ann, promising to advise them later whether to follow him. Soon after, the son received this letter from his father:
"It is wonderful to be back in Russia. I am enjoying life very much. Come over as soon as you can —but not until after Ann's wedding."

A preacher recently announced that there are 735 sins. He is being besieged with requests for the list, mostly from college students who think they're missing something.

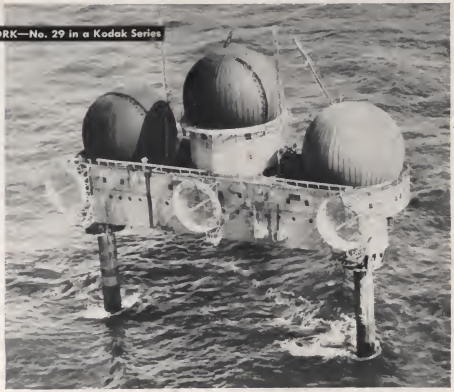
"Daddy, if you give me a nickel I'll tell you what the iceman said to Mama."
"All right, here's your nickel."
"He said, 'Any ice today?' "

"How do you manage to keep drinking that Union coffee?"
"I take a spoonful of Drano every week."

THE MECHELECIV

PHOTOGRAPHY AT WORK—No. 29 in a Kodak Series

Sturdy sea legs for Radar eyes



One of America's offshore radar warning towers—Texas Tower III—built by Walsh Holyoke Division, Continental Copper and Steel Industries, Inc.

—*with every seam proved sound on X-ray film*

In record time, Continental Copper and Steel Industries, Inc. built and launched "Texas Tower III" and every weld was checked by radiography.

Here is a steel island 110 miles at sea—2700 tons of 2-deck platform setting on staunch and stalwart caisson legs 272 feet long. It is destined to stand against the hammering of giant seas and howling hurricane gales.

No place here for the tiniest flaw in a single weld! So the magic of radiography was called on to make sure. Two and a half miles of x-ray film hold positive proof that every seam has showed itself flaw-free and secure.

Everyday radiography is working like this for welders, large and small—for foundries interested in making sound castings —for any manufacturer who must know internal conditions of a product without destroying it. It is one example of the many ways photographic processes work for business and industry—how it helps make better products and improve manufacturing procedures.

CAREERS WITH KODAK

With photography and photographic processes becoming increasingly important in the business and industry of tomorrow, there are new and challenging opportunities at Kodak in research, engineering, electronics, design and production. If you are looking for such an interesting opportunity, write for information about careers with Kodak. Address: Business and Technical Personnel Department, Eastman Kodak Company, Rochester 4, N. Y.

EASTMAN KODAK COMPANY
Rochester 4, N. Y.

Kodak
TRADEMARK

One of a series

Interview with General Electric's
Frank T. Lewis
Mgr., Manufacturing Personnel Development

The Next Four Years: Your Most Important

The United States is now doubling its use of electrical energy every eight years. In order to maintain its position as the leading manufacturer in this fast-growing electrical industry, General Electric is vitally interested in the development of young engineers. Here, Mr. Lewis answers some questions concerning your personal development.

Q. Mr. Lewis, do you think, on entering industry, it's best to specialize immediately, or get broad experience first?

A. Let me give you somewhat of a double-barreled answer. We at General Electric think it's best to get broad experience in a specialized field. By that, I mean our training programs allow you to select the special kind of work which meets your interests—manufacturing, engineering, or technical marketing—and then rotate assignments to give you broad experience within that area.

Q. Are training assignments of a predetermined length and type or does the individual have some influence in determining them?

A. Training programs, by virtue of being programs, have outlined assignments but still provide real opportunities for self-development. We try our best to tailor assignments to the individual's desires and demonstrated abilities.

Q. Do you mean, then, that I could just stay on a job if I like it?

A. That's right. Our programs are both to train you and help you find your place. If you find it somewhere along the way, to your satisfaction and ours, fine.

Q. What types of study courses are included in the training programs and when are the courses taken?

A. Each of our programs has graduate-level courses conducted by experienced G-E engineers. These courses supplement your college training and tie it in with required industrial techniques. Some are taken on Company time, some on your own.

Q. What kind of help do you offer employees in getting graduate schooling?

A. G.E.'s two principal programs of graduate study aid are the Honors Program and the Tuition Refund Program. If accepted on the Honors Program you can obtain a master's degree, tuition free, in 18 months while earning up to 75% of full-time salary. The Tuition Refund Program offers you up to 100% refund of tuition and related fees when you complete graduate courses approved by your department manager. These courses are taken outside normal working hours and must be related to your field of work.

Q. What are the benefits of joining a company first, then going into military service if necessary.

A. We work it this way. If you are hired and are only with the Company a week before reporting to military service, you are considered to be performing continuous service while you are away and you will have your job when you return. In determining your starting salary again, due consideration is given experience you've gained and changes in salary structure made in your absence. In addition, you accrue pension and paid-vacation rights.

Q. Do you advise getting a professional engineer's license? What's it worth to me?

A. There are only a few cases where a license is required at G.E., but we certainly encourage all engineers to strive for one. At present, nearly a quarter of our engineers are licensed and the percentage is constantly increasing. What's it worth? A license gives you professional status and the recognition and prestige that go with it. You may find, in years to come, that a license will be required in more and more instances. Now, while your studies are fresh in your mind, is the best time to undertake the requirements.

Your next four years are most important. During that period you'll undoubtedly make your important career decisions, select and complete training programs to supplement your academic training, and pursue graduate schooling, if you choose. These are the years for personal development — for shaping yourself to the needs of the future. If you have questions still unanswered, write to me at Section 959-6, General Electric Co., Schenectady 5, N. Y.

LOOK FOR other interviews discussing: • Salary • Advancement in Large Companies • Qualities We Look for in Young Engineers.

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